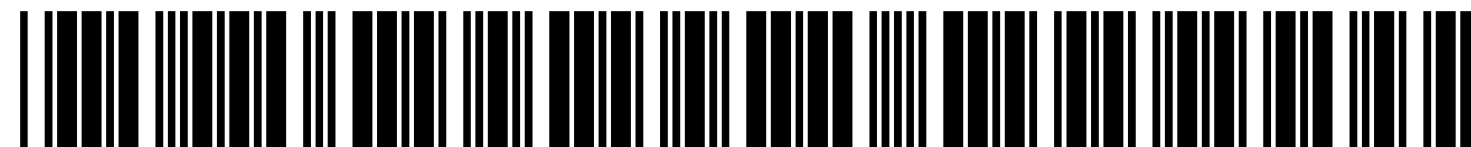
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(54) **HEAT SINK**

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H01L 23/34	(2006.01)
H01L 23/367	(2006.01)
H01L 23/467	(2006.01)
H01L 21/48	(2006.01)

(52) **U.S. Cl.**

CPC ***H01L 23/34*** (2013.01); ***H01L 23/3672*** (2013.01); ***H01L 23/467*** (2013.01); *H01L 21/4882* (2013.01); *H01L 2924/0002* (2013.01)

(58) **Field of Classification Search**

CPC ... H01L 23/467; H01L 23/3672; F28D 7/103; F28D 7/10; F28D 7/12

USPC 165/80.3, 184

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,303,107 A * 5/1919 Oderman F28D 3/02 165/117
2,712,520 A * 7/1955 Nester B01D 3/30 159/6.2
2,869,836 A * 1/1959 Huet F28F 1/22 165/165
2,870,999 A * 1/1959 Soderstrom B21C 37/26 165/156
2,895,508 A * 7/1959 Drake F28F 1/40 138/38
3,027,314 A * 3/1962 Vaughan C02F 11/00 165/184
3,239,003 A * 3/1966 Boudette B21D 53/02 165/185
3,265,115 A * 8/1966 Maier B01D 1/065 159/13.2
3,372,095 A * 3/1968 Nester B01D 3/10 159/6.2

(Continued)

FOREIGN PATENT DOCUMENTS

WO WO 03065775 A2 * 8/2003 .... H01L 23/467

OTHER PUBLICATIONS

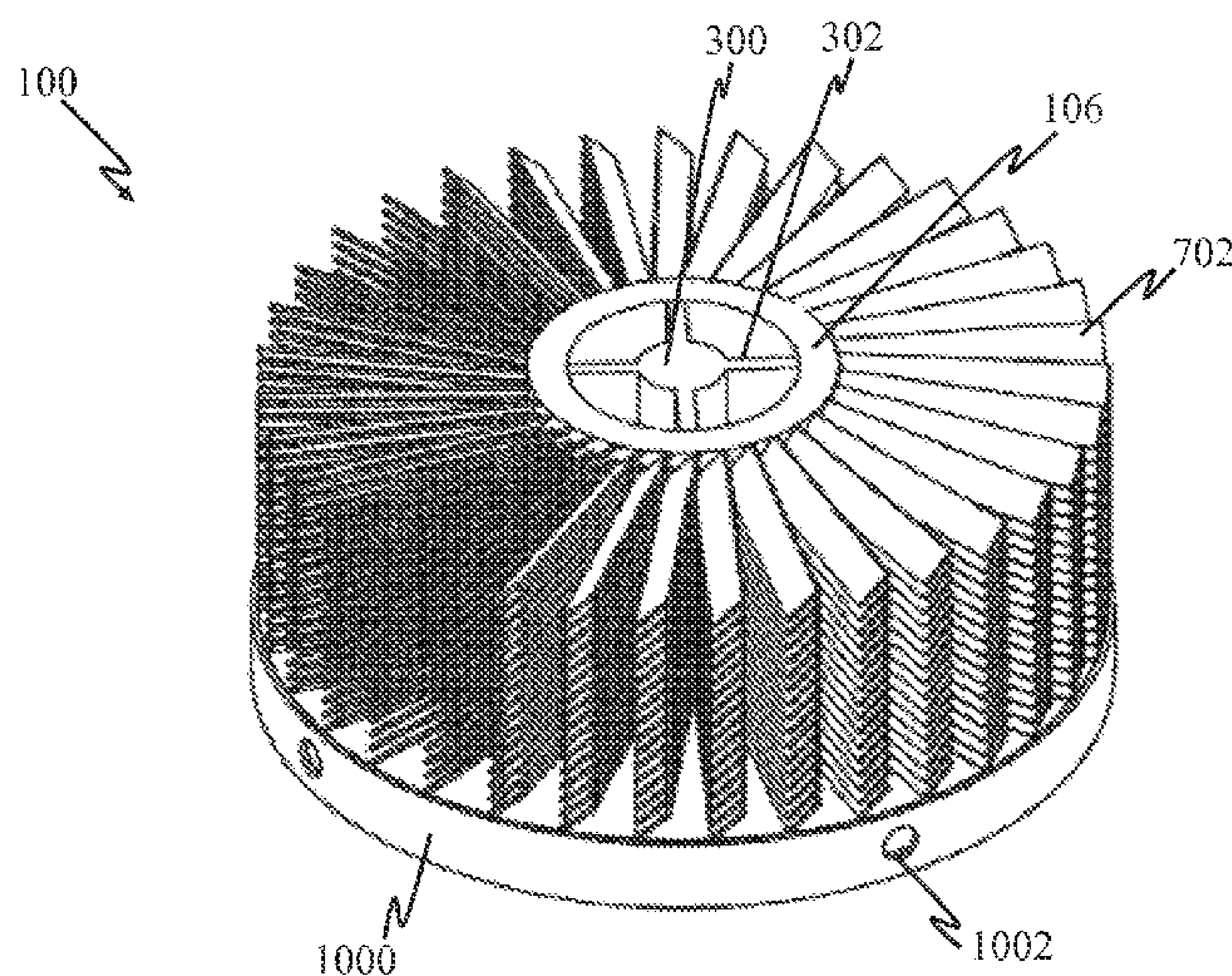
Chung, Materials for thermal conduction, Mar. 15, 2000, p. 2, table 1.*

Primary Examiner — Claire Rojohn, III

(57) **ABSTRACT**

A heat sink (**100**) for an electronic device comprising a first plate (**102**), a second plate (**104**) and a pipe (**106**). One side of the first plate (**102**) is in thermal contact with the electronic device. The second plate (**104**) is in thermal contact with the other side of the first plate (**102**). Further, the second plate (**104**) includes a hole and placed such that, a gap for airflow maintained between the first plate (**102**) and the second plate (**104**). One end the pipe (**106**) thermally coupled to the second plate (**104**). Thus facilitating the air flowing into the pipe (**106**) through the other end escapes the heat sink through the gap maintained between the first plate (**102**) and the second plate (**104**) via the hole on the second plate (**104**).

16 Claims, 10 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

3,633,343 A * 1/1972 Mark F01N 3/0217 55/323
3,636,982 A * 1/1972 Drake F28F 1/40 138/38
3,956,072 A * 5/1976 Huse B01D 1/289 159/24.1
3,983,861 A * 10/1976 Beauchaine F24S 10/70 126/656
4,090,559 A * 5/1978 Megerlin F28F 1/40 138/38
4,190,105 A * 2/1980 Dankowski B60H 1/3227 138/38
4,325,781 A * 4/1982 Proske B01D 1/10 159/13.2
4,534,409 A * 8/1985 Cadars F28F 13/12 138/38
4,784,218 A * 11/1988 Holl F28F 13/02 138/38
5,132,780 A * 7/1992 Higgins, III H01L 23/467 165/104.34
5,361,188 A * 11/1994 Kondou H01L 23/467 165/104.34
5,454,429 A * 10/1995 Neurauter F28D 7/16 138/38
5,782,292 A * 7/1998 Ogawara H01L 23/467 165/122
5,787,976 A * 8/1998 Hamburgen F28F 3/02 165/185
6,092,589 A * 7/2000 Filius F25B 39/02 138/38
6,219,242 B1 * 4/2001 Martinez H05K 7/20154 165/121
6,288,895 B1 * 9/2001 Bhatia G06F 1/203 165/104.33
6,561,261 B2 * 5/2003 Wagner H01L 23/467 165/121
6,702,002 B2 * 3/2004 Wang H01L 23/367 165/104.33
6,816,374 B2 * 11/2004 Patel G06F 1/20 165/121
6,827,138 B1 * 12/2004 Master F28D 7/1607 165/159
6,845,010 B2 * 1/2005 Lee H01L 23/3672 165/104.33
7,055,577 B2 * 6/2006 Wang H01L 23/467 165/185
7,108,139 B2 * 9/2006 Nguyen B01D 27/06 210/437
7,142,422 B2 * 11/2006 Lee H01L 23/4006 165/104.33
7,269,013 B2 * 9/2007 Chen H01L 23/4006 165/104.19
7,584,780 B1 * 9/2009 Lemont H01L 23/467 165/125
7,785,448 B2 * 8/2010 Owens B01D 1/06 203/10
7,929,302 B2 * 4/2011 Chuang G06F 1/20 165/121
8,196,643 B2 * 6/2012 Chen H01L 21/4878 165/128
8,256,258 B2 * 9/2012 Yamaoka B21C 23/08 29/890.03
8,354,779 B2 * 1/2013 Falicoff F21K 9/00 313/35
9,005,393 B2 * 4/2015 Owens B01D 1/06 15/398
9,782,702 B2 * 10/2017 Carrion B01D 29/56
2002/0038699 A1 * 4/2002 Wagner H01L 23/467 165/80.3
2003/0102110 A1 * 6/2003 Wagner F28F 1/105 165/80.3
2003/0189813 A1 * 10/2003 Lee H01L 23/3672 361/704
2005/0145366 A1 * 7/2005 Erel H01L 23/467 165/80.3
2005/0257914 A1 * 11/2005 Huang H01L 23/3672 165/80.3
2006/0086484 A1 * 4/2006 Hegde F28D 15/0275 165/104.33
2006/0196636 A1 * 9/2006 Liu H01L 23/467 165/80.3
2007/0023163 A1 * 2/2007 Kidwell F24J 3/084 165/45
2007/0159798 A1 * 7/2007 Chen H01L 23/4006 361/700
2008/0029243 A1 * 2/2008 O'Donnell F24H 3/087 165/48.1
2008/0035315 A1 * 2/2008 Han F04D 17/04 165/121
2008/0120981 A1 * 5/2008 Dean F04F 7/00 62/6
2009/0000327 A1 * 1/2009 Burk F25B 17/086 62/324.6
2009/0211729 A1 * 8/2009 Wang H01L 23/467 165/80.3
2010/0177480 A1 * 7/2010 Koplow F04D 25/0606 361/697
2011/0103011 A1 * 5/2011 Koplow F04D 25/0606 361/679.54
2013/0039072 A1 * 2/2013 Kim F21V 29/006 362/294
2013/0167570 A1 * 7/2013 Bouloy F25B 39/02 62/156
2013/0175017 A1 * 7/2013 Goto B21D 11/14 165/181
2014/0127091 A1 * 5/2014 Wang F28F 1/40 422/198
2014/0190668 A1 * 7/2014 Joshi H01L 23/4735 165/104.33
2015/0000876 A1 * 1/2015 Yang F28D 15/00 165/104.31
2015/0159957 A1 * 6/2015 Baxi F25B 40/00 165/109.1
2016/0047541 A1 * 2/2016 Jones .... F24D 5/08 126/91 A
2016/0053653 A1 * 2/2016 Han F01N 5/025 62/3.3
2016/0131040 A1 * 5/2016 Agg F02C 7/224 60/785
2016/0363379 A1 * 12/2016 Strecker F28D 7/12

* cited by examiner

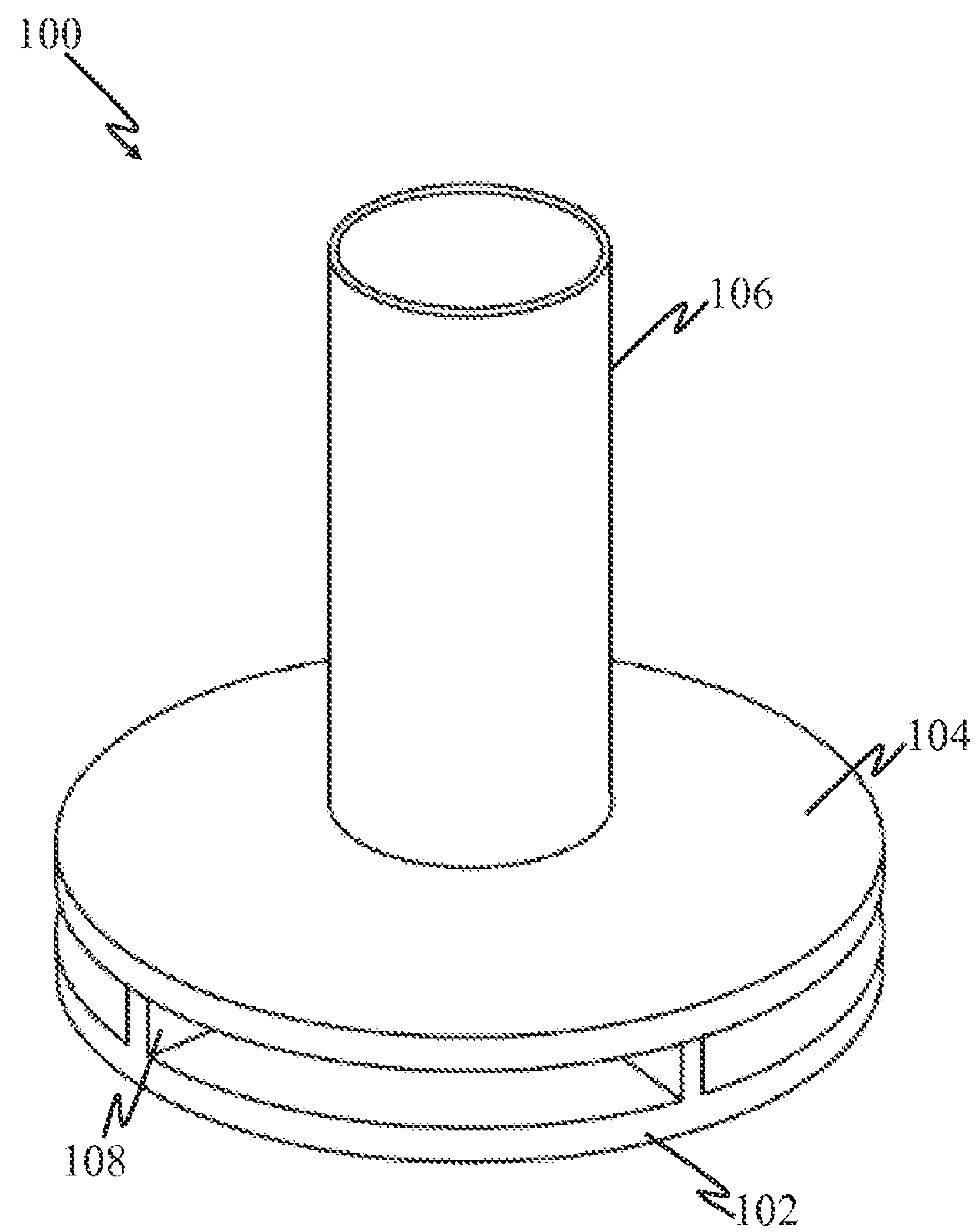


FIG. 1

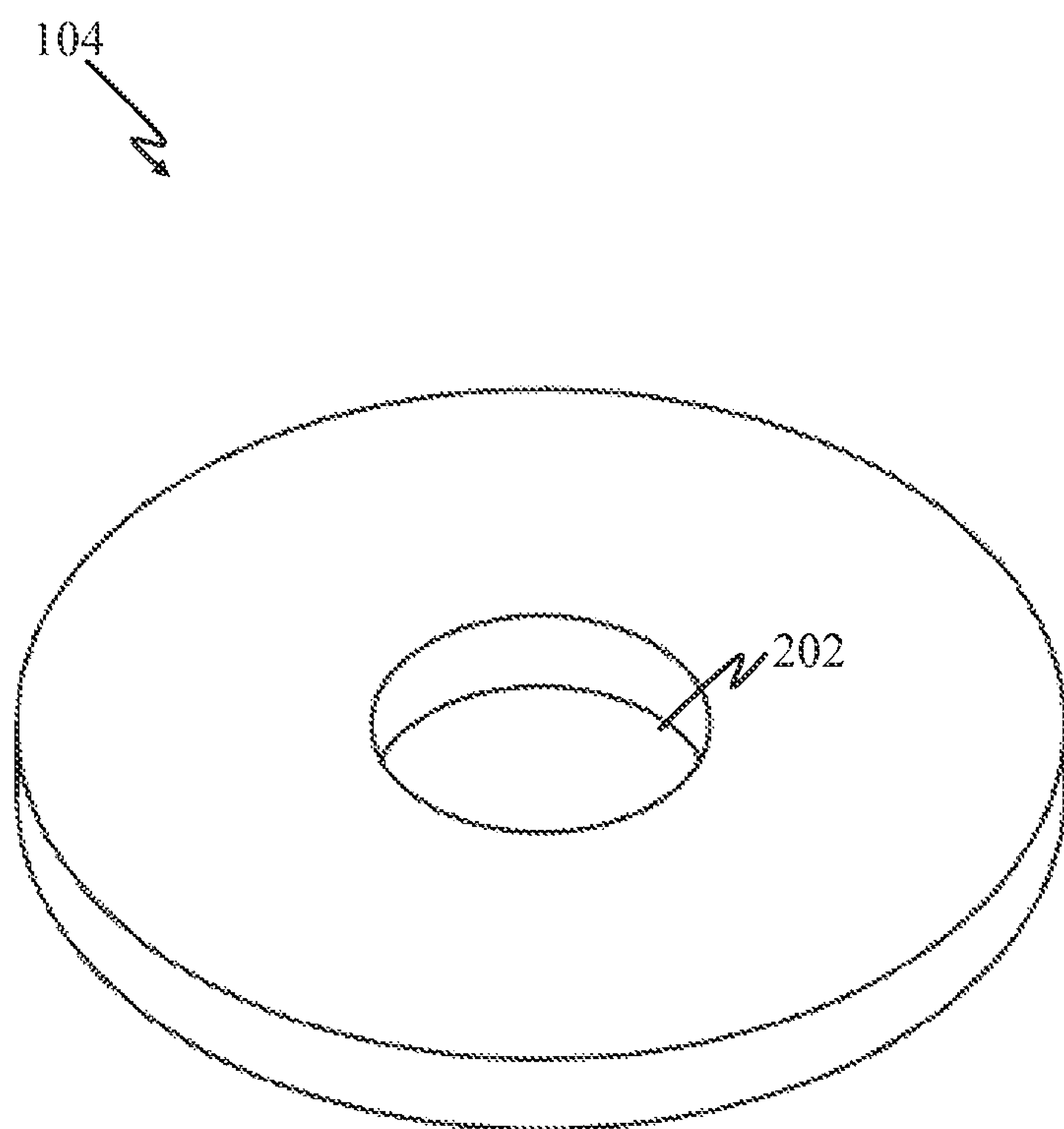


FIG. 2

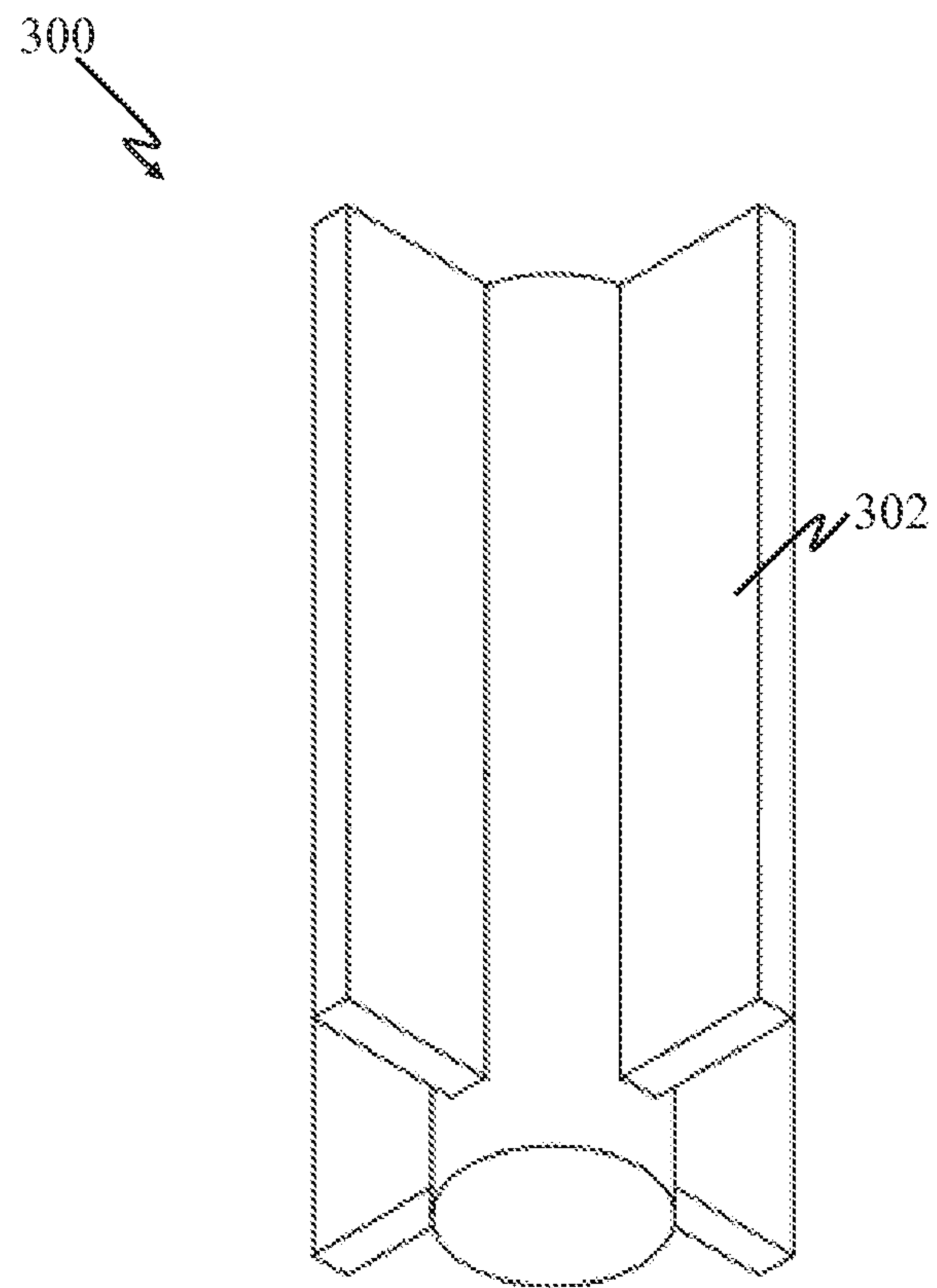


FIG. 3

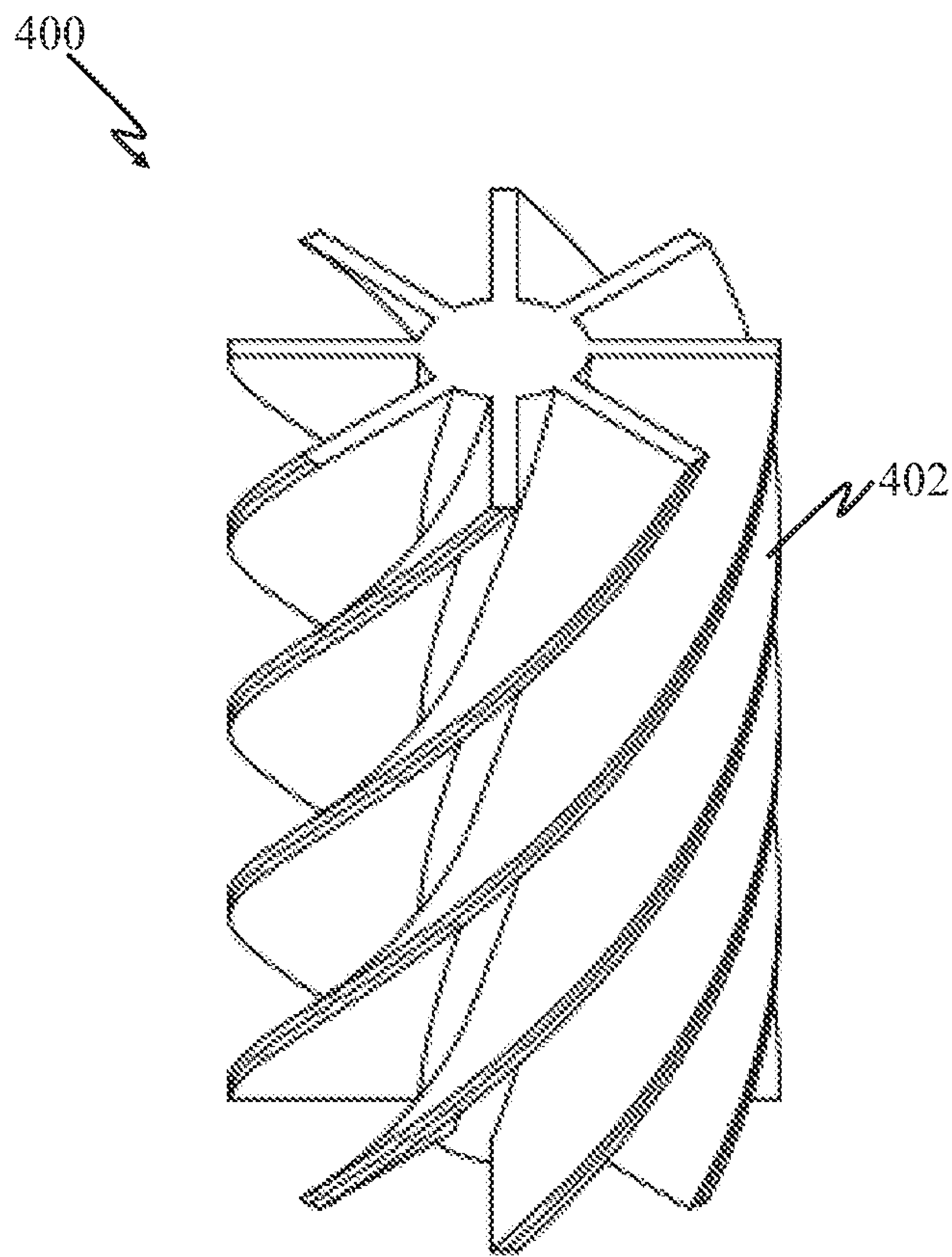


FIG. 4

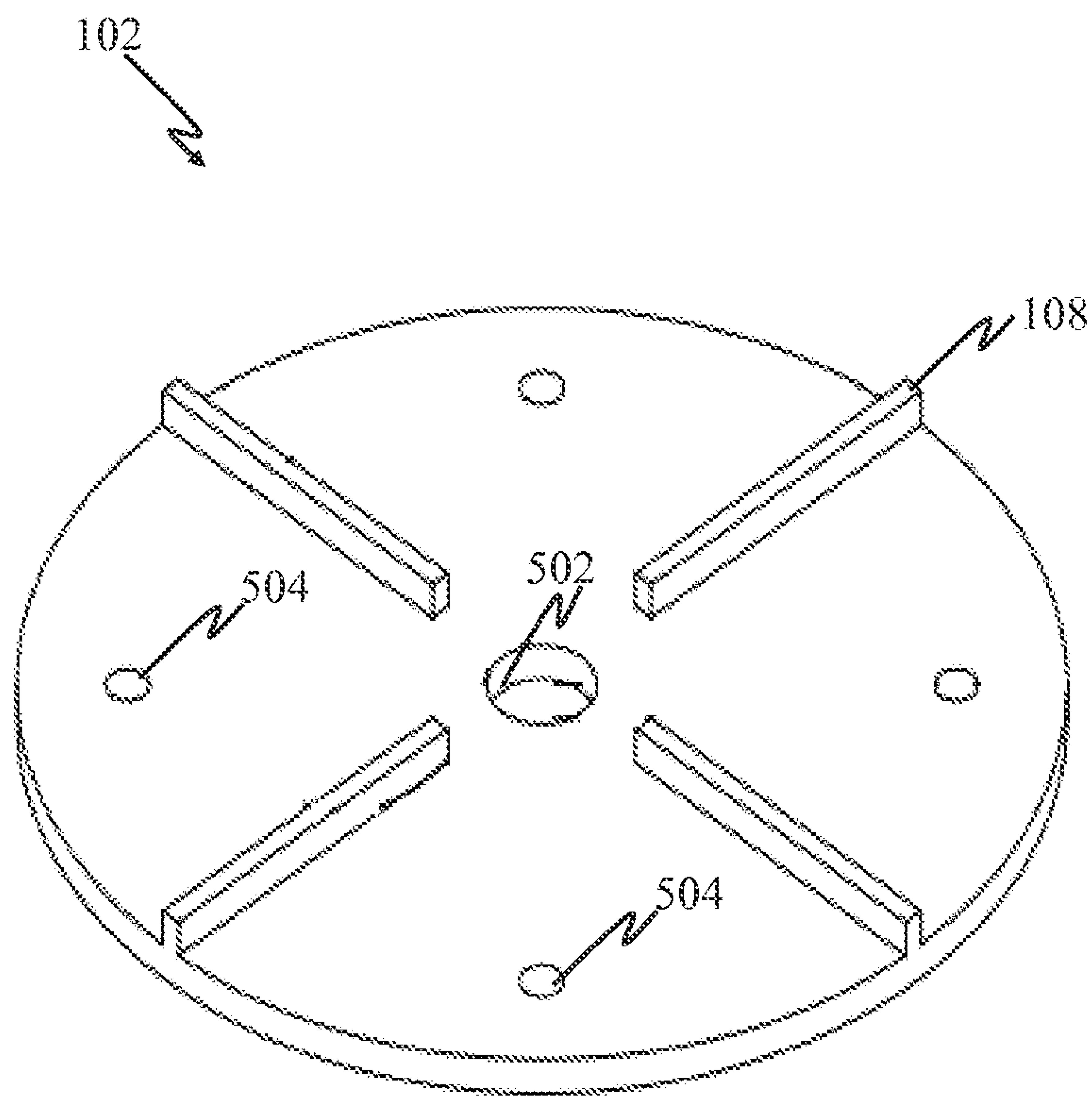


FIG. 5

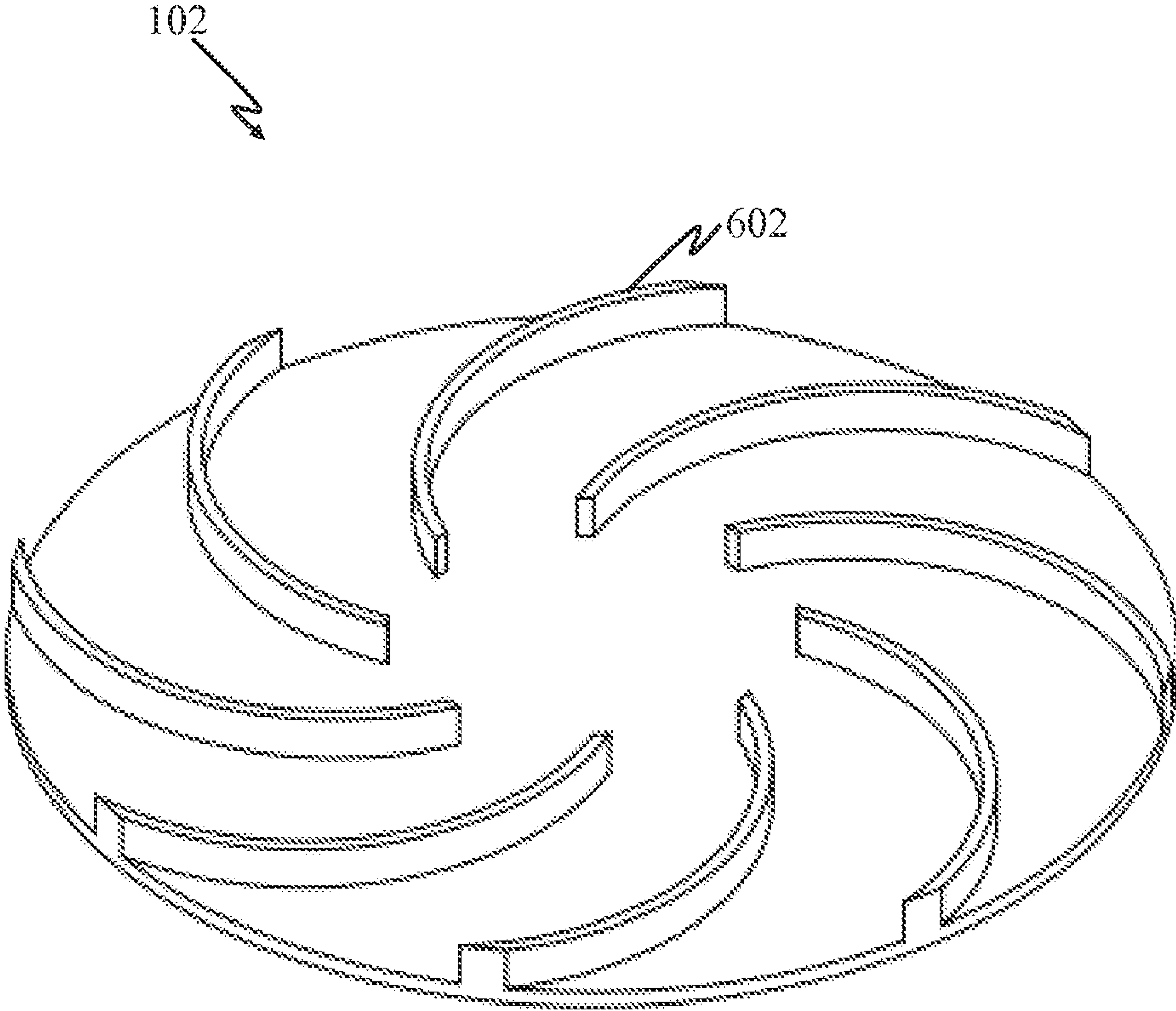


FIG. 6

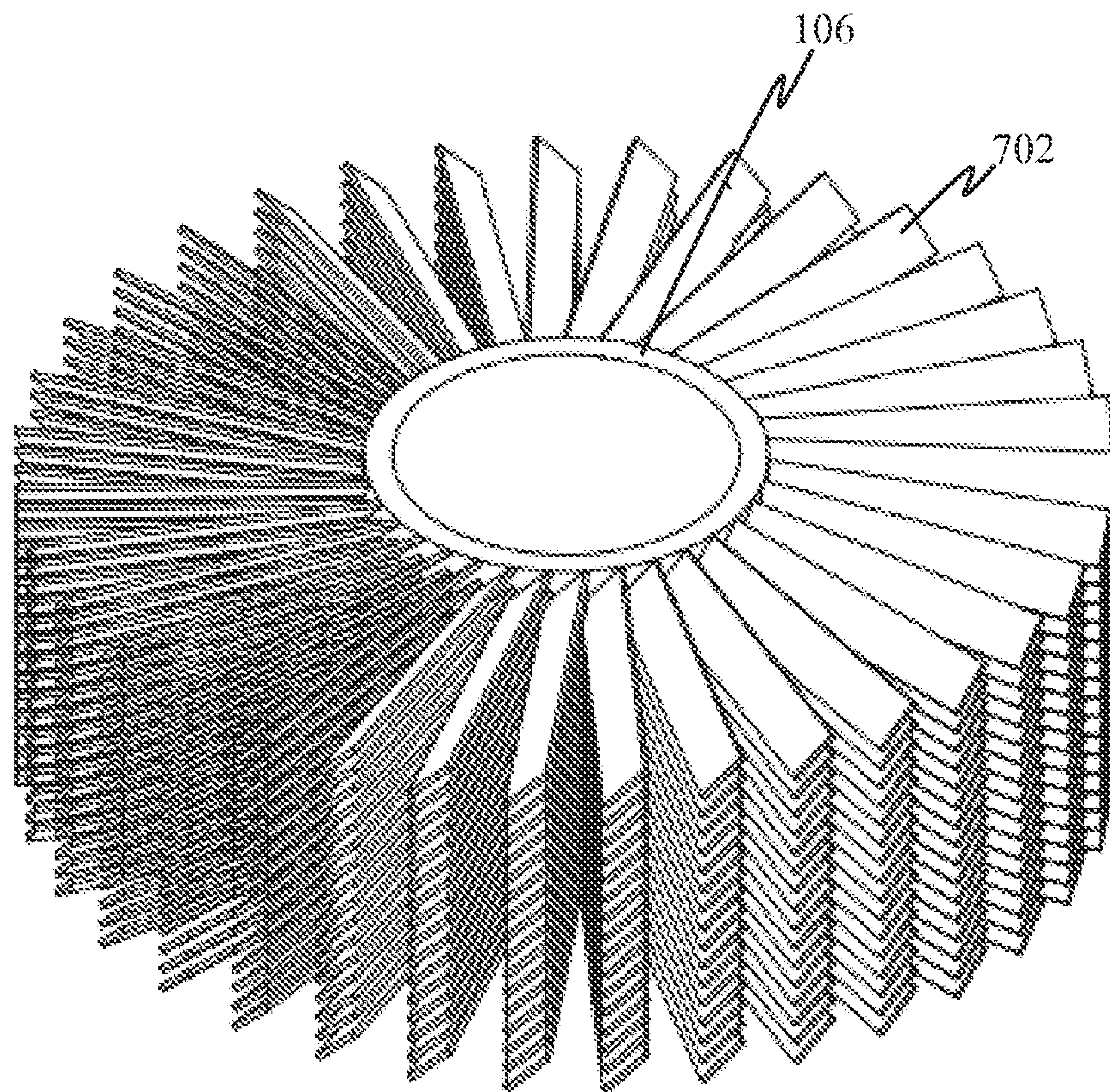


FIG. 7

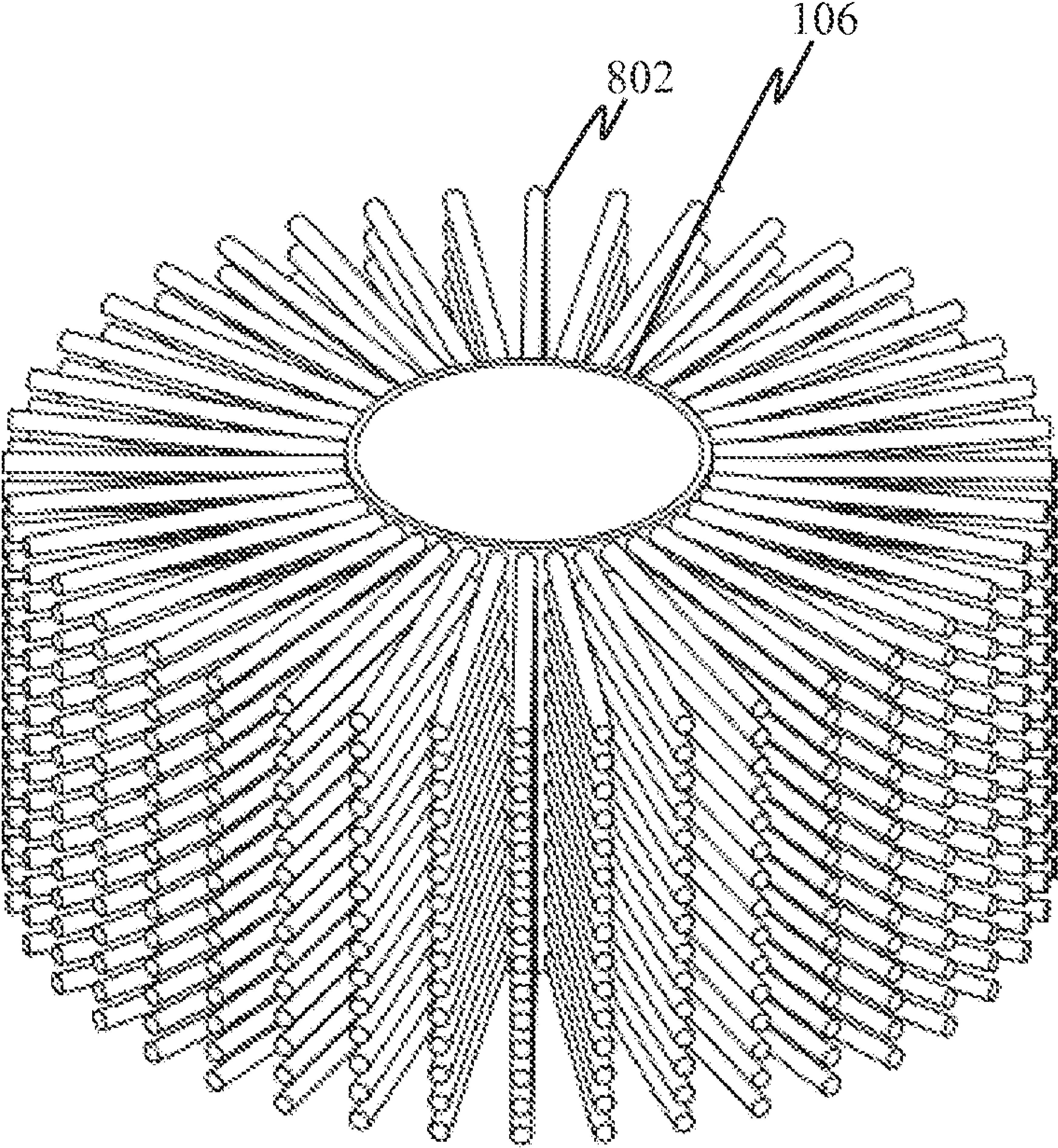


FIG. 8

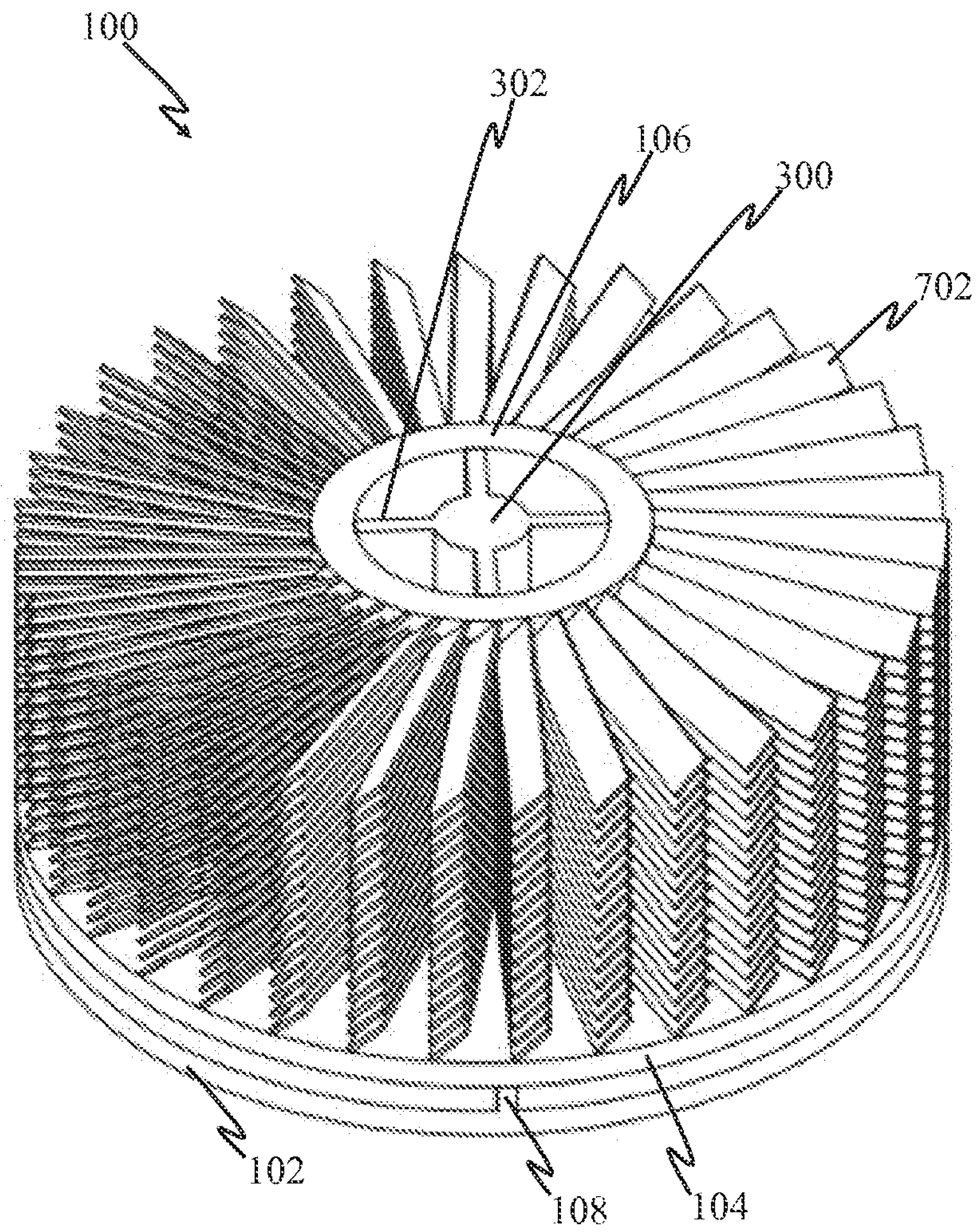


FIG. 9

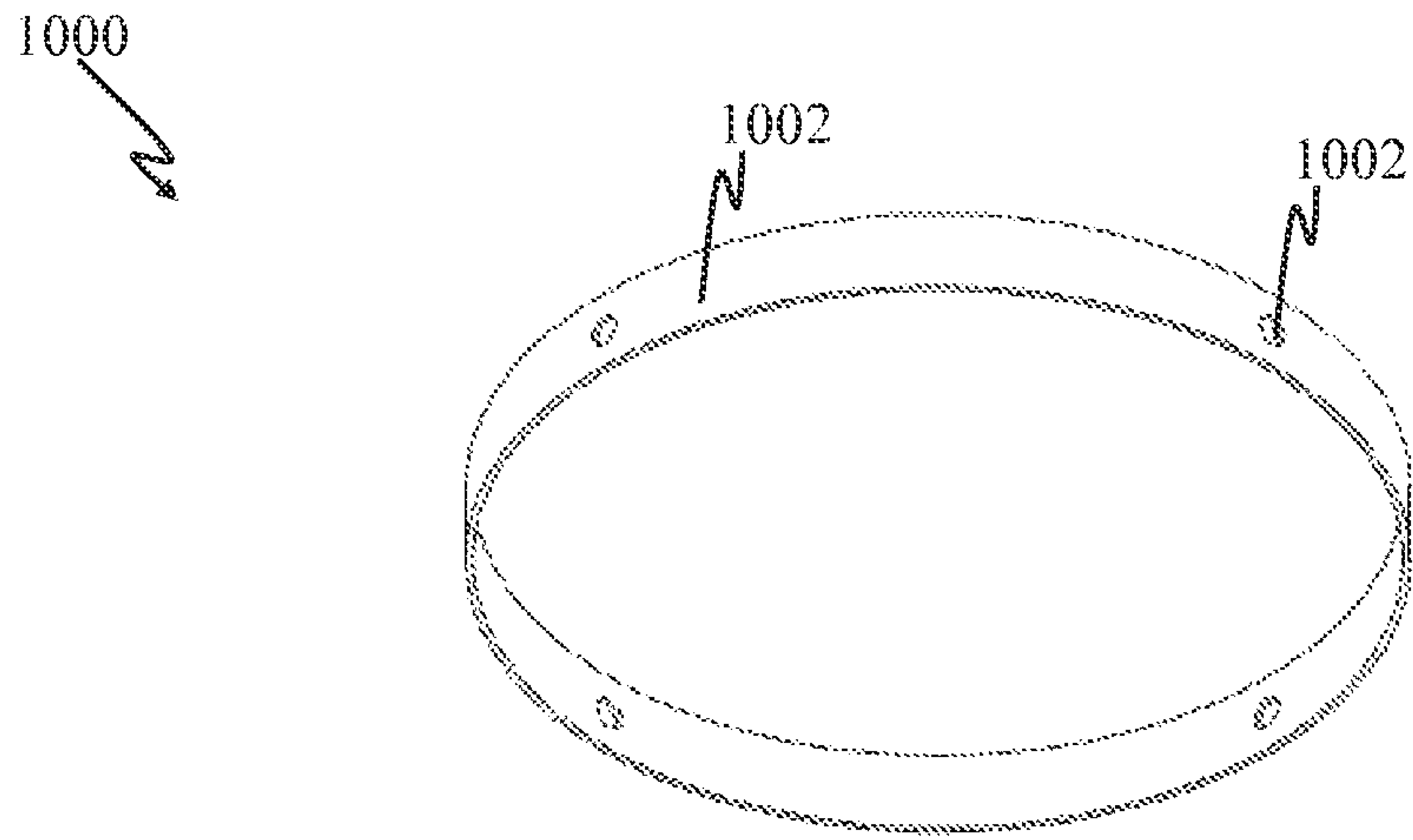


FIG. 10a

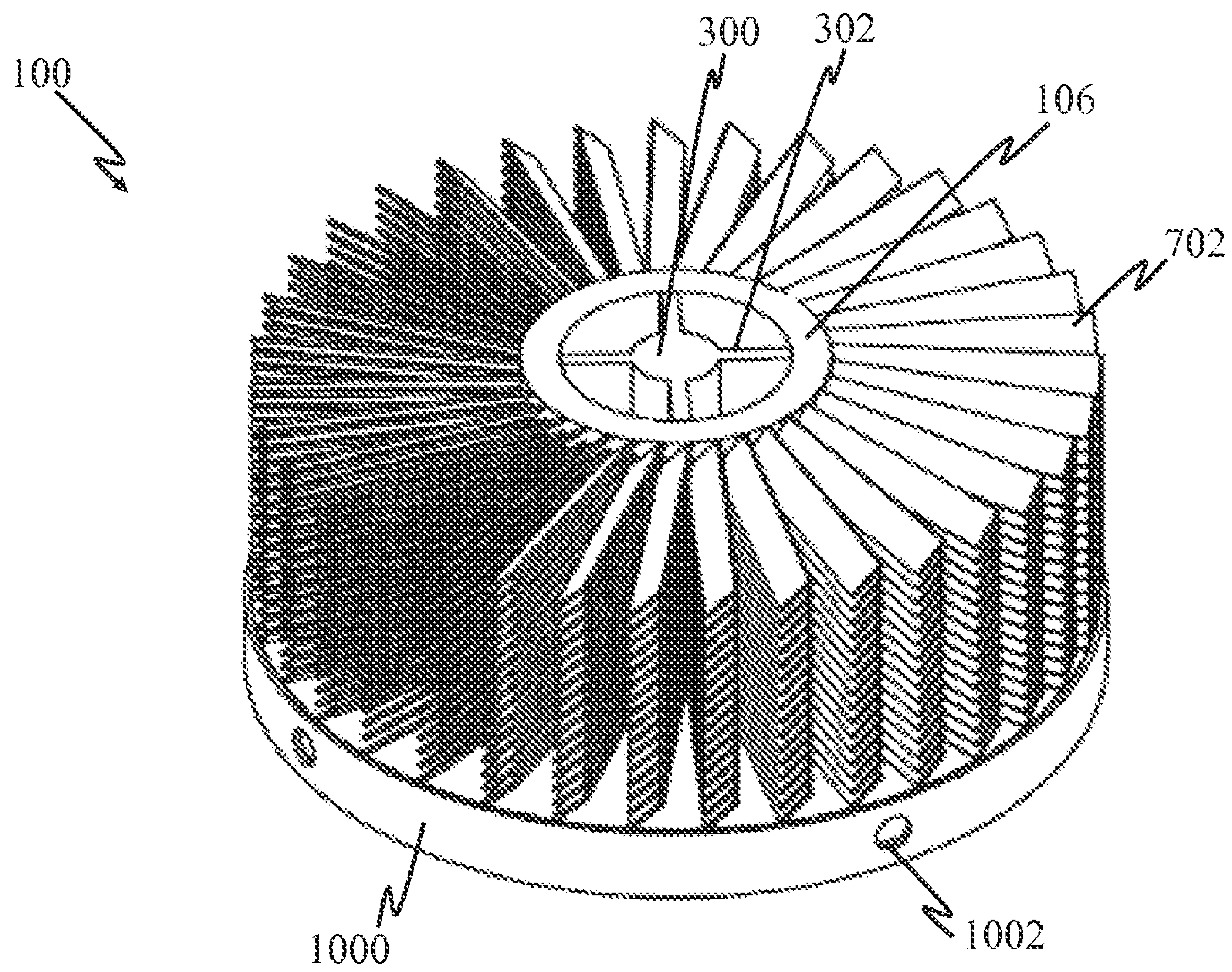


FIG. 10b

HEAT SINK

BACKGROUND

Field of the Subject Matter

The subject matter relates to the field of heat sinks, more particularly but not exclusively, to heat sinks used for integrated circuits.

Discussion of Related Field

Electronic devices, such as, personal computer and laptops, among others, use one or more microprocessors. These microprocessors while operating at higher speeds generate heat. The heat generated can damage the microprocessor and other components associated with it. Therefore, heat sink, which is a type of heat exchanger, is used to overcome this problem.

Heat sinks are used to conduct the heat generated by the microprocessor and dissipate it into the environment, thereby allowing safe operation of the microprocessor. Heat sinks are generally categorized into two, namely, active heat sinks and passive heat sinks.

Passive heat sinks are metal fixtures associated with the microprocessor to increase the surface area of the conducting metal and dissipate heat into the environment. However, case of higher speed processors, which dissipates more heat, a much bigger passive heat sink is required for efficient operation of the microprocessor and to prevent it from physical damage. This requires constant increase in size of the heat sinks with ever-increasing speeds of the microprocessors, thereby increasing overall size of the electronic device, which includes such microprocessors.

Active heat sinks may be used to overcome the problem associated with size of the passive heat sinks. The active heat sinks include a fan to cool the metal fixtures. Incorporating a fan will overcome the problem of size. However, for efficient cooling of the heat sink, the air blown by the fan has to be directed, such that, it passes through the maximum possible surface area of the heat sink. Further, there should be a proper design for the air to exit the heat sink.

In light of the foregoing discussion, there is a need for a technique to implement a heat sink with improved efficiency.

STATEMENT OF INVENTION

Accordingly, the invention provides a heat sink including a first plate, a second plate and a pipe. One side of the first plate is in thermal contact with the electronic device. The second plate is in thermal contact with the other side of the first plate. Further, the second plate includes a hole and placed such that, a gap for airflow is maintained between the first plate and the second plate. One end the pipe is thermally coupled to the second plate. Thus facilitating the air flowing into the pipe through the other end escapes the heat sink through the gap maintained between the first plate and the second plate via the hole on the second plate.

BRIEF DESCRIPTION OF DRAWINGS

Embodiments are illustrated by way of example and not limitation the Figures of the accompanying drawings, in which like references indicate similar elements and in which:

FIG. **1** illustrates an example heat sink **100**, in accordance with an embodiment;

FIG. **2** illustrates an example isometric view of a second plate **104**, in accordance with an embodiment;

FIG. **3** illustrates an example isometric view of a supporting section **300**, in accordance with an embodiment;

FIG. **4** illustrates an example isometric view of another type of supporting section **400**, in accordance with an embodiment;

FIG. **5** illustrates an example isometric view of a first plate **102** compatible with supporting section **300**, in accordance with an embodiment;

FIG. **6** illustrates an example isometric view of another type of first plate **102** compatible with supporting section **400**, in accordance with an embodiment;

FIG. **7** illustrates an example isometric view of a pipe **106** with a plurality of fins **702**, in accordance with an embodiment;

FIG. **8** illustrates an example isometric view of the pipe **106** with a plurality of horizontal poles **802**, in accordance with an embodiment;

FIG. **9** illustrates an example isometric view of the heat sink **100** with the supporting section **300** and the pipe **106** with a plurality of fins **702**, in accordance with an embodiment;

FIG. **10*a*** illustrates an example isometric view of a ring **1000** covering the space between the first plate **102** and second plate **104**, and allowing the air to exit through holes **1002**, in accordance with an embodiment; and

FIG. **10*b*** illustrates an example isometric view of a heat sink **100** with the ring **1000**, in accordance with an embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

I. Overview
II. Exemplary Diagrams
III. Conclusion

I. OVERVIEW

The subject matter relates to the field of heat sinks, more particularly but not exclusively, to heat sinks used for integrated circuits.

Embodiments disclose an improved heat sink for efficient cooling of integrated circuits.

The improved heat sink includes a first plate, a second plate, and a pipe coupled to the first plate and the second plate. One side of the first plate is in thermal contact with an electronic device. The second plate is in thermal contact with the first plate. The second plate is placed on other side of the first plate, such that, a gap for airflow is maintained between the first plate and the second plate.

The following detailed description includes references to the accompanying drawings, which form a part of the detailed description. The drawings show illustrations in accordance with example embodiments. These example embodiments, which are herein also referred to as "examples" are described in enough detail to enable those skilled in the art to practice the present subject matter. The embodiments can be combined, other embodiments can be utilized, or structural, logical, and design changes can be made without departing from the scope of the claims. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope is defined by the appended claims and their equivalents.

In this document, the terms "a" or "an" are used, as is common in patent documents, to include one or more than one. In this document, the term "or" is used to refer to a

nonexclusive “or,” such that “A or B” includes “A hut not B,” “B but not A,” and “A and B,” unless otherwise indicated.

II. EXEMPLARY DIAGRAMS

FIG. **1** illustrates an example heat sink **100**, in accordance with an embodiment. The heat sink **100** includes a first plate **102**, a second plate **104** and a pipe **106**. One side of the first plate **102** is in thermal contact with an electronic device, such that, it can absorb the heat from the electronic device.

The second plate **104** is in thermal contact with the first plate **102**. Further, the second plate **104** is placed on other side of the first plate **102**, such that, a gap for airflow is maintained between the first plate **102** and the second plate **104**.

In an embodiment, the gap between the first plate **102** and the second plate **104** is maintained by using one or more wall sections **108** as indicated in the FIG. **1**.

In an embodiment, the first plate **102** and the second plate **104** are good conductors of heat and can be made of one or more metals, such as, but not limited to, aluminum, copper, and aluminum alloy.

In an embodiment, thermally coupled means, the two or more sections are in physical contact with each other and are capable of exchanging heat.

In an embodiment, two sections are said to be in thermal contact with each other, if they are capable of exchanging heat even without a physical contact.

In an embodiment, an electronic device can be any integrated circuit, not limiting to, microprocessor and graphic processor.

The pipe **106** is thermally coupled to the second plate **104**. Further, the ends on either side of the pipe **106** are open.

FIG. **2** illustrates an example isometric view of the second plate **104**, in accordance with an embodiment. The second plate **104** includes a hole **202**. One end of the pipe **106** is coupled to the second plate, such that, the air entering through the other end of the pipe **106** escapes via the hole **202** through the gap maintained between the first plate **102** and the second plate **104**.

In an embodiment, the air is directed into the heat sink **100** by placing a fan on top of the heat sink **100**.

In an embodiment, the pipe **106** can be internally divided into two or more sections along the axis of the pipe **106** to increase the surface area of the heat sink **100**.

FIG. **3** illustrates an example isometric view of a supporting section **300**, in accordance with an embodiment. The supporting section **300** is thermally coupled to the first plate **102**, the second plate **104** and the pipe **106**. The supporting section **300** is placed inside the pipe **106** extending from the other end of the pipe **106** till the hole **502** on the first plate **102**, where it may be coupled to the first plate **102**. The supporting section **300** can include partitioning walls **302** along the axis of the pipe **106**.

FIG. **4** illustrates an example isometric view of another type of supporting section **400**, in accordance with an embodiment. The supporting section **400** is placed inside the pipe **106** and the supporting section **400** can include partitioning walls **402** to increase the surface area of the heat sink.

FIG. **5** illustrates an example isometric view of the first plate **102** compatible with supporting section **300**, in accordance with an embodiment. The first plate **102** can include one or more wall sections **108** and a hole **502** to accommodate one end of the supporting section **300**. Further, the first plate **102** can also include one or more holes **504** to fix the heat sink **100** on top of the electronic device.

FIG. **6** illustrates an example isometric view of another type of first plate **102** compatible with supporting section **400**, in accordance with an embodiment. The first plate can include one or more wall sections **602** to support the supporting section **400**, in accordance with an embodiment.

FIG. **7** illustrates an example isometric view of the pipe **106** with a plurality of fins **702**, in accordance with an embodiment. A plurality of fins **702**, are externally coupled or brazed to the pipe **106**. The fins **702** are brazed at an angle in the direction of rotation of the fan, placed over the heat sink **100**. The angle is chosen such that, maximum air flows through the plurality of fins **702**, thereby maximizing efficiency of the heat sink **100**. The preferred angle of the fins **702** is 45 degrees in the direction of rotation of rotation of fan.

FIG. **8** illustrates an example isometric view of the pipe **106** with a plurality of horizontal poles **802**, in accordance with an embodiment. A plurality of horizontal poles **802** are externally coupled or brazed to the pipe **106**.

FIG. **9** illustrates an example isometric view of the heat sink **100** with the supporting section **300** and the pipe **106** with a plurality of fins **702**, in accordance with an embodiment. When a fan is placed over the heat sink **100**, air flows through the vertical sections inside the pipe **106** and exits through the gap between the first plate **102** and the second plate **104**. Further, the air focused on the exterior of the pipe **106** flows through the fins **702**. The angle of the fins **702** is such that, the air flow is directed towards substantial number of fins **702**, thus directing the air through maximum possible surface area.

FIG. **10*a*** illustrates an example isometric view of a ring **1000** covering the space between the first plate **102** and second plate **104**, and allowing the air to exit through the holes **1002**, in accordance with an embodiment. The ring **1000** is used to limit the airflow, through the gap between the first plate **102** and the second plate **104**. The ring **1000** allows the air entering the pipe **106** to exit through the holes **1002**. Thus, the air is forced to stay inside the pipe and between the plates **102** and **104** for a longer duration.

FIG. **10*b*** illustrates an example isometric view of a heat sink **100** with the ring **1000**, in accordance with an embodiment. In an embodiment, the ring **1000** is brazed or coupled, to the outer surface of the first plate **102** and the second plate **104**. Further the holes **1002** provided in the ring **1000** allows the air entering the pipe **106** to limit the airflow. Thus, the air is forced to stay inside e heat sink **100** for a longer duration.

In an embodiment, the pipe **106**, the supporting section **300**, the supporting section **400** the fins **702**, the horizontal poles **802**, the wall section **108** the wall section **602**, the ring **1000**, the partitioning walls **302**, and the partitioning walls **402** are good conductors of heat, and can be made of one or more metals, such as, but not limited to, aluminum, copper and aluminum alloy.

III. CONCLUSION

The aforementioned heat sink achieves considerable efficiency by efficiently directing air through the heat sink. The fins or the horizontal poles, which are coupled to the pipe improves the surface area of the heat sink, thereby further enhancing the efficiency of the heat sink.

Although, embodiments have been described with reference to specific example embodiments, it will be evident that various modifications, arrangements of components and

changes may be made to these embodiments without departing from the broader spirit and scope of the heat sink described herein. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense.

Many alterations and modifications of the present invention will no doubt become apparent to a person of ordinary skill in the art after having read the foregoing description. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. It is to be understood that the description above contains many specifications, these should not be construed as limiting the scope of the invention but as merely providing illustrations of some of the personally preferred embodiments of this invention. Thus the scope of the invention should be determined by the appended claims and their legal equivalents rather than by the examples given.

What is claimed is:

1. A heat sink comprising:

a first plate, wherein one side of the first plate is in thermal contact with an electronic device;

a second plate in thermal contact with the first plate, wherein the second plate includes a hole and placed on other side of the first plate, such that, a gap for airflow is maintained between the first plate and the second plate;

a pipe whose one end is thermally coupled to the second plate, such that, air flowing into the pipe through other end of the pipe escapes the heat sink through the gap maintained between the first plate and the second plate via the hole; and

a supporting section, which is stationary, the supporting section comprising an elongated member and a plurality of partition walls, the partition walls extending from the elongated member and in physical contact with an inner surface of the pipe to thermally couple the supporting section to the pipe, while defining at least a first passage and a second passage for air between the elongated member, partition walls and the inner surface of the pipe, the partition walls extending till the second plate and terminating at the second plate, and the elongated member extending till the first plate to be in physical contact with the first plate, wherein the supporting section is inside the pipe, such that:

air enters the first passage at the other end of the pipe, and escapes the pipe and the first passage at the one end of the pipe; and

air enters the second passage at the other end of the pipe, and escapes the pipe and the second passage at the one end of the pipe;

wherein the supporting section extends from the other end of the pipe till the first plate, while passing through the hole of the second plate, while allowing the air flowing into the pipe through the other end of the pipe escape the heat sink through the gap maintained between the first plate and the second plate, wherein the elongated member is a solid cylindrical rod.

2. The heat sink according to claim **1**, further comprising a plurality of fins externally coupled to the pipe.

3. The heat sink according to the claim **2**, wherein the plurality of fins are at an angle in a direction of rotation of a fan, wherein the angle is in the range of 30 degrees to 60 degrees.

4. The heat sink according to the claim **2**, wherein the fins are made of, at least one of, aluminum, copper and aluminum alloy.

5. The heat sink according to claim **1**, further comprising a plurality of horizontal poles externally coupled to the pipe.

6. The heat sink according to claim **1**, wherein the pipe's internal volume is divided into two or more sections along an axis of the pipe.

7. The heat sink according to claim **1**, wherein the first plate comprises a hole.

8. The heat sink according to the claim **1**, wherein the supporting section is made of, at least one of, aluminum, copper and aluminum alloy.

9. The heat sink according to claim **1**, wherein the supporting section is along an axis of the pipe.

10. The heat sink according to the claim **1**, wherein the partitioning walls are made of at least one of aluminum, copper and aluminum alloy.

11. The heat sink according to claim **1**, wherein at least one of the first plate and the second plate are separated by wall sections to maintain the gap for the airflow between the first plate and the second plate.

12. The heat sink according to the claim **1**, wherein at least one of the first plate, the second plate and the pipe, is made of, at least one of, aluminum, copper and aluminum alloy.

13. The heat sink according to the claim **1**, further comprising a ring with at least one hole, wherein the ring is configured to limit the airflow through the gap between the first plate and the second plate.

14. The heat sink according to the claim **13**, wherein the ring is made of at least one of aluminum, copper and aluminum alloy.

15. The heat sink according to the claim **1**, wherein the partitioning walls are straight in shape.

16. The heat sink according to the claim **1**, wherein the partitioning walls are spiral.

* * * * *